

## A COST/SCHEDULE AND CONTROL SYSTEM FOR THE ENVIRONMENTAL RESTORATION PROGRAM ALBUQUERQUE FIELD OFFICE

Wanda S. Fiske, Edward L. Bischoff, Kenneth H. Rea, Ph.D.,  
P. Dwain Farley, Ph.D. and Charles A. Biedermann  
Los Alamos National Laboratory

### ABSTRACT

The Department of Energy (DOE) Field Office Albuquerque (AL), Environmental Restoration Project Office (ERPO), has developed a project management system used to plan, document, and control Environmental Restoration (ER) work at eight installations and one superfund site managed by AL. This system emphasizes control of the cost, schedule, and technical elements of the Program. It supports programmatic documentation such as the Environmental Restoration/Waste Management Five-Year Plan, Site Specific Plan, and budget requests. The System provides information used to manage the ER Program at all levels of management (i.e., from low-level day-to-day activities to high-level upper management). The System requires substantial effort to ensure reliability; however, the benefit to ERPO is an effective, proactive project management tool.

This paper provides an overview of the ERPO System, an explanation of how it is implemented, and lessons learned from this process. Application of the System to cost estimating, annual and five-year budget preparation, resource projections, scheduling, and cost/schedule performance measurement is discussed. Also discussed are cost/schedule review procedures, along with variance identification and resolution. Examples are taken from the Pinellas ER Program.

### COST/SCHEDULE AND CONTROL SYSTEM

Cost and schedule control is a top priority for the Department of Energy (DOE) Environmental Restoration (ER) Program. Increasing emphasis is coming both from internal and external sources for efficient management systems. For example, R. P. Whitfield, Deputy Assistant Secretary for Environmental Restoration stated in a January 21, 1992 Memorandum:

"Sound technical cost and schedule baselines are essential for effective management of our activities. Further, I believe that the project management of our systems that are being implemented will enable us to respond to the numerous inquiries from Congress, regulators and the public in an efficient manner."

Externally, DOE ER programs are in the midst of audits by the Office of Management and Budget, General Accounting Office, House Appropriations Committee, and Office of Inspector General. These audits focus on the management systems in place at all levels within DOE (i.e. Headquarters, Field Offices, and Installations).

The AL, Environmental Restoration Project Office (ERPO) began development of a project management system in 1989 to promote credibility and accountability with optimum cost and benefit (Fig. 1). Cost/Schedule Control System Criteria (C/SCSC) requirements are applied to provide a consistent, well-documented basis for project control. These criteria are modified to account for several unique characteristics of the ER Program. The following highlights the major components of the ERPO System:

**Work Breakdown Structure.** A product oriented Work Breakdown Structure (WBS) identifies the hierarchy of work required to complete the ER Program. ERPO prepared the Project WBS to describe the process for completing deliverables necessary to comply with the applicable regulatory agreement at each installation (Fig. 2). The WBS deliverable level corresponds to the cost account level where work is controlled by AL.

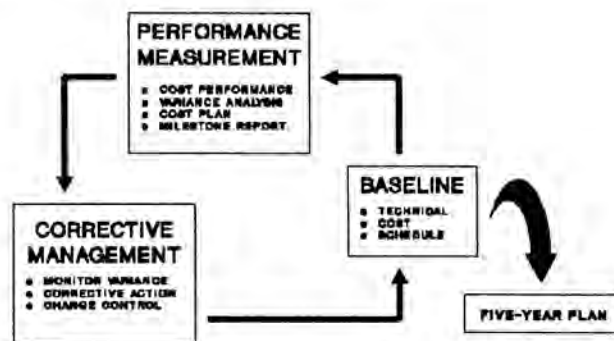


Fig. 1. Integrated project management system.

**Baselines.** Cost, schedule, and technical baselines are constructed for each WBS level subproject at an installation. Regulatory deliverables established by the Resource Conservation and Recovery Act (RCRA), the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the National Environmental Policy Act (NEPA) and other regulatory requirements are the foundation of the baseline. The baseline is established for each subproject at the WBS deliverable level and is used as the approved standard against which accomplishments, progress and expenditures are measured and the program controlled.

The baseline includes three interrelated elements: 1) technical specifications which define the primary regulatory driver(s), nature and extent of contamination, assessment and remediation technology, and deliverables; 2) schedules which focus on regulatory drivers that determine the timing and sequencing of activities; and, 3) cost estimates, derived from the unit costs of defined resources that establish time-phased total estimated costs. The baseline is developed by the installation and is independently validated before acceptance by ERPO for performance measurement.

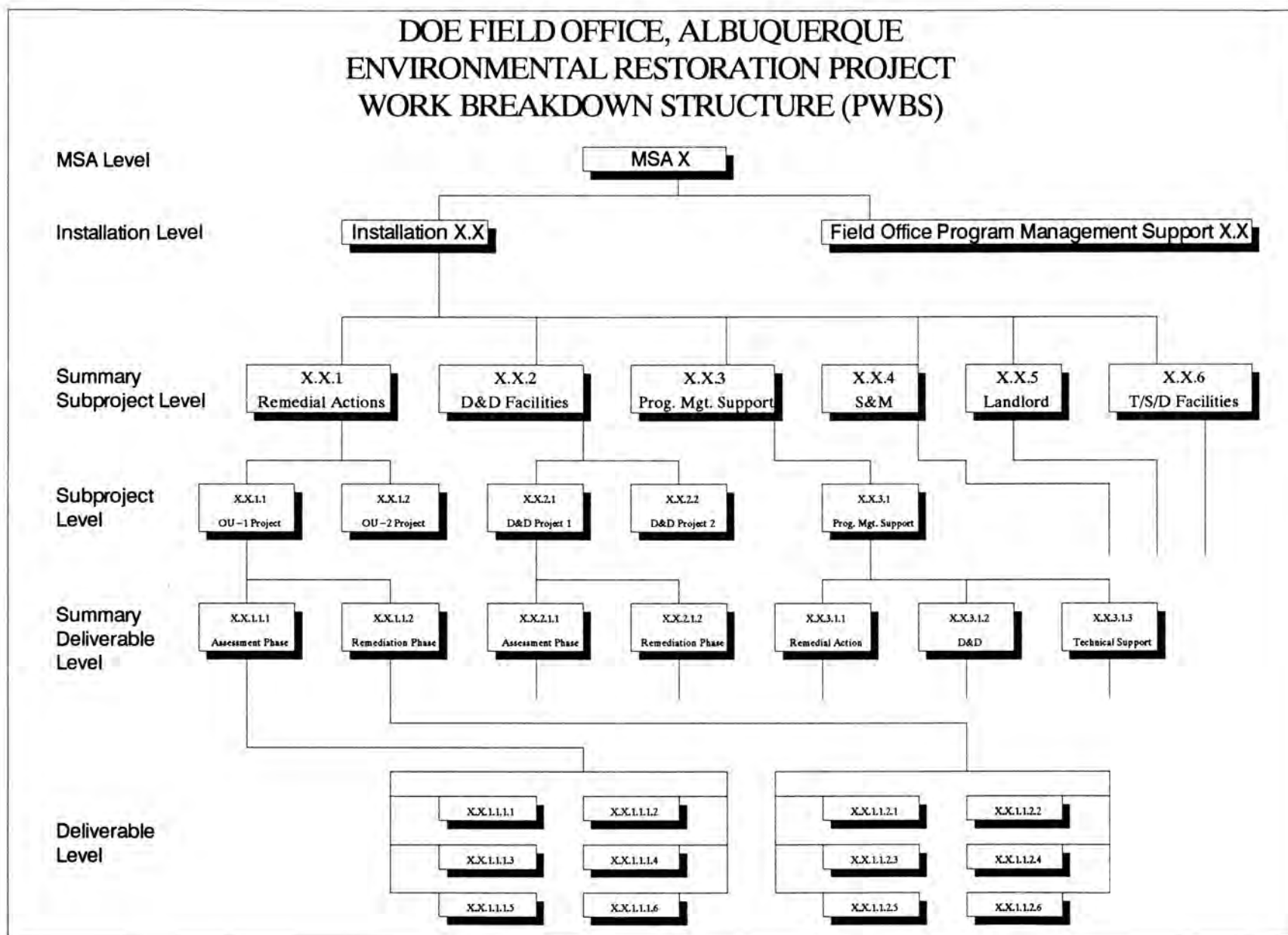


Fig. 2. Project work breakdown structure.

The schedule provides a time-phased logical relationship to the various activities required to successfully execute each project phase. The schedule is a project's "blueprint" and provides the technical framework for effective project management. Logic relationships between activities, activity durations, resource requirements and milestones are among the major attributes of the schedule. These elements are arranged to create the schedule within the WBS framework.

Cost estimates for the assessment phase of ER are generally produced using a resource-based methodology. Here, a resource table of the labor, material, equipment, and sub-contract cost items is constructed. Scheduling software with resource-based estimating capability is used to assign costs to the tasks identified in the schedule. When assessment nears completion, standard design/construction type project estimating techniques are used to estimate costs.

**Performance Reporting.** Program management is exercised by assessing the progress of work against the approved baseline. ERPO tracks cost and schedule variance(s) for both the current period and cumulatively. The philosophy is to manage by exception because projects within cost and schedule do not need the same management oversight attention as a project with a significant cost or schedule variance. Each installation collects and reports the actual cost of work performed (ACWP) at the WBS Deliverable level. The status (start, complete, or future) of every activity is recorded. This cost and activity status data is translated into either a cost or schedule variance. Any variance above a threshold set by ERPO must be documented and assessed.

A report is transmitted monthly from each installation to ERPO. A review of the report is then completed to assure maintenance of baseline integrity and identification of potential problems and appropriate corrective action. The validated report from each installation is integrated into the ERPO Cost/Schedule Performance Report which is provided to the Manager of the AL Field Office and to DOE Headquarters. The report consists of the following:

- **Cost Performance Report.** The Cost Performance Report (CPR) provides the basis for cost/schedule performance data measurement (Fig. 3). The CPR utilizes the standard C/SCSC Format 1. It displays the WBS summary deliverables and compares the Budgeted Cost of Work Performed (BCWP) with the Budgeted Cost of Work Scheduled (BCWS) and with the Actual Cost of Work Performed (ACWP) to calculate schedule and cost variances. It also compares the budget at completion (BAC) with the estimate at completion (EAC) to calculate variance at completion (VAC), all expressed in dollars.
- **Cost Performance Graph.** The Cost Performance Graph is simply a picture of BCWS, BCWP, and ACWP in graphical format by month. This graph is useful to managers for quick identification of significant cost/schedule variances and trends.
- **Variance Analysis Report.** A Variance Analysis Report is required when a Cost Variance (CV) or Schedule Variance (SV) is identified in the CPR that is above predetermined variance tolerance thresholds set by ERPO. The report identifies the issues, explains the reasons for the variances, describes impacts on the deliverables, and defines corrective ac-

tions to be taken. It is the blueprint for any corrective action.

- **Cost Plan.** The budget and planning process are merged with the output of the Cost Plan (CP) (Fig. 4). The CP reflects the portion of the approved baseline which an installation plans to complete during the current fiscal year consistent with the Approved Financial Plan, and also provides a view of the budget and Five-Year Planning windows. The CP also defines the activities in monthly increments which an installation is responsible for managing and, thus, provides time-phased data upon which performance can be measured and reported to ERPO. The Cost Plan reports the baseline dollars for each WBS summary deliverable time-phased for the current fiscal year, up-coming budget year, and summarized for the Five-Year Planning window. It supports the Five-Year Plan, Approved Financial Plan and funds management for trend projections.
- **Milestone Report.** The Milestone Report identifies all ERPO, Installation, and Headquarters milestones at the WBS deliverable level. It shows the planned start and finished dates and compares these to updated estimates and actual completions.
- **Change Control Log.** The Change Control Log summarizes the status of all proposed requests to change the performance measurement baseline.

**Change Control.** Change control procedures provide a formal process for changing the baseline due to: 1) a change in work scope; 2) use of management reserve and contingency; or 3) to accommodate the need to rebaseline when setbacks result in an unmeaningful baseline. They assure the exercise of appropriate management control of changes, maintenance of baseline integrity, coordination of changes among sub-projects, and traceability from cradle to grave on baselined activities. Thresholds are established for cost, schedule, and technical elements to assure management control of changes. Any proposed change to the baseline that exceeds a threshold must be approved at the corresponding management level (Installation, Field Office, or Headquarters) prior to implementation.

## PROGRAMMATIC BENEFITS

The programmatic benefits derived from the ERPO Program Management System fall into three general categories: planning improvements, effective program management, and enhanced program credibility and traceability.

**Planning Improvements.** The System provides for identification and integration of all elements that will affect the cost, schedule or technical requirements of ER. For example, each product of the WBS deliverable level requires considerable internal review prior to submission to the regulator. In addition, contract procurement requirements may require significant lead time to avoid work delays. The System integrates the review/document preparation tasks, contract tasks, and regulatory deadlines into the schedule of technical work resulting in the most efficient baseline. The ERPO System provides a disciplined approach which promotes complete planning, scheduling, and budgeting of characterization and cleanup work.

ALBUQUERQUE OPERATIONS OFFICE  
 ENVIRONMENTAL RESTORATION PROJECT OFFICE  
 COST PERFORMANCE REPORT (\$K)

PROJECT NAME: PINELLAS PLANT		SUBMITTED BY:				CONTRACTOR RESPONSIBLE: GEND LANL-ER/TSO														
DATE: 14-JAN-92		REPORTING LEVEL: OU				CURRENT PERIOD: 01-DEC-91 TO 31-DEC-91														
WBS	TASK	----- CURRENT PERIOD -----								----- CUMULATIVE TO DATE -----								----- AT COMPLETION -----		
		BUDGETED COST		ACTUAL COST WORK PERF	VARIANCE		VARIANCE %		BUDGETED COST		ACTUAL COST WORK PERF	VARIANCE		VARIANCE %		BUDGETED	LATEST REVISED EST.	VARIANCE		
		WORK SCHED	WORK PERF		SCHED- ULE	COST	SCHED- ULE	COST	WORK SCHED	WORK PERF		SCHED- ULE	COST	SCHED- ULE	COST					
1.0	ADS-1001--4.5 ACRE SITE ASSE	29.2		32.3	-29.2	-32.3	-100%	-INF%	434.2	310.9	329.4	-123.3	-18.5	-28%	-6%	475	494	-19		
2.0	ADS#: 1002 4.5 Acre Site Re	21.2	160.0	21.0	138.8	138.9	656%	87%	1563.7	1564.7	1479.7	1.1	85.1	0%	5%	5740	5655	85		
1.0	ADS-1003--AL-PI-3 INSTALL.	7.4	2.8	-1.7	-4.6	4.5	-62%	162%	275.0	112.3	150.1	-162.7	-37.8	-59%	-34%	1568	1606	-38		
2.0	ADS#:1004-Floridan Aquifer R															15280	15280			
1.0	ADS-1005--AL-PI-4 - MISC SIT	32.2	9.3	52.8	-22.9	-43.5	-71%	-469%	1978.6	2066.3	2007.3	87.7	59.0	4%	3%	3013	2954	59		
2.0	ADS#: 1006 - Misc. Sites			0.3		-0.3			84.5	84.5	57.5		27.1	0%	32%	26500	26473	27		
1.0	ADS-1007--NEPA EA/EIS	4.2		7.1	-4.2	-7.1	-100%	-INF%	59.9	75.8	53.1	15.9	22.6	27%	30%	220	197	23		
1.0	ADS#:1010-Peak Oil Assessmen	7.2			-7.2		-100%		34.0	11.7	11.7	-22.3		-66%	0%	621	621			
2.0	ADS#:1011-Peak Oil Remediat															1248	1248			
2.0	Sludge Holding Tank Closure		10.4	-0.3	10.4	10.7	INF%	103%	64.4	64.4	73.0		-8.6	0%	-13%	317	325	-9		
2.0	ADS#: 1013 - Project Mgt.	10.6	10.6	15.2	0.0	-4.6	0%	-43%	247.8	247.5	257.6	-0.3	-10.1	-0%	-4%	4475	4485	-10		
	SUBTOTAL	112	193	127	81	66	73%	34%	4742	4538	4419	-204	119	-4%	3%	59457	59338	119		
	ESCALATION \$															13638				
	MANAGEMENT RESERVE \$															0				
	CONTINGENCY \$															30218				
	TOTAL															103313				
Remarks: (a) "At Completion" reflects cost and schedule baseline for: 1) All assessment ADSs; 2) ER program management ADSs; 3) ER miscellaneous ADSs; 4) remediation ADSs starting before 01-Oct-93.																Reviewed By:				

Fig. 3. Cost performance report.

ALBUQUERQUE OPERATIONS OFFICE  
 ENVIRONMENTAL RESTORATION PROJECT OFFICE  
 FY 1992 COST PLAN (\$K)

PROJECT NAME: PINELLAS PLANT		SUBMITTED BY:		CONTRACTOR RESPONSIBLE: GEND LANL ERTSO																		
DATE: 30-JAN-92		REPORTING LEVEL: OU		CURRENT PERIOD: 01-DEC-91 TO 31-DEC-91																		
WBS	TASK	PRIOR FY's TOTAL	PLANNED DOLLARS (\$K) CURRENT FISCAL YEAR: 1992												BUDGET YEAR	FIVE-YEAR PLAN WINDOW					BUDGET AT COMPLETION	
			OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP		TOTAL	93	94	95	96		97
1.0	ADS-1001--4.5 ACRE SITE ASSE	289	116	8	20	5	18	3	3	2	3	3	3	3	186	0	0	0	0	0	0	475
2.0	ADS#: 1002 4.5 Acre Site Re	1498	24	20	22	25	23	26	23	21	70	79	76	52	462	880	523	523	523	484	5740	
1.0	ADS-1003--AL-PI-3 INSTALL.	251	2	18	5	1	75	2	1	2	2	1	1	111	588	586	33	0	0	0	1568	
2.0	ADS#:1004-Floridan Aquifer R	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1267	1539	2543	2784	1664	15280
1.0	ADS-1005--AL-PI-4 - MISC SIT	1880	39	32	27	98	69	67	93	202	112	65	82	47	933	200	0	0	0	0	0	3013
2.0	ADS#: 1006 - Misc. Sites	57	0	27	0	0	35	152	108	69	61	58	79	591	2107	7004	2164	2184	2179	2141	26500	
1.0	ADS-1007--NEPA EA/EIS	47	5	4	4	5	4	5	5	5	5	5	5	5	58	58	58	0	0	0	220	
1.0	ADS#:1010-Peak Oil Assessmen	12	8	7	8	8	7	8	8	7	8	8	8	8	91	182	336	0	0	0	621	
2.0	ADS#:1011-Peak Oil Remediat	0	0	0	0	0	0	0	0	0	0	0	0	0	0	500	400	200	148	0	1248	
2.0	Sludge Holding Tank Closure	64	0	0	0	3	0	0	2	0	0	7	84	60	156	10	10	10	10	10	317	
2.0	ADS#: 1013 - Project Mgt.	207	20	10	11	13	11	14	11	10	11	10	9	9	139	216	347	294	295	272	4475	
SUBTOTAL																						
PLAN		4306	215	127	97	158	133	234	299	357	280	239	325	263	2725	4240	10631	4963	5756	5940	4572	59457
FYTD PLAN			215	342	438	596	729	963	1262	1619	1898	2137	2462	2725								
ESCALATION \$																126	805	642	1056	1413	1348	13638
MANAGEMENT RESERVE \$															0	0	0	0	0	0	0	0
CONTINGENCY \$															824	2435	3666	2440	3748	4218	2936	30218
TOTAL															3549	6801	15102	8046	10559	11571	8856	103313
PLAN																						
CARRYOVER \$															400							
BUDGET AUTHORITY \$															3149							
Remarks: (a) "Budget At Completion" reflects cost and schedule baseline for: 1) All assessment ADSs; 2) ER program management ADSs; 3) ER miscellaneous ADSs; 4) remediation ADSs starting before 01-Oct-93.																		Reviewed By:				

Fig. 4. Cost plan.

Through more complete planning, technical improvements are realized. Examples are acceleration of characterization schedules, application of the observational approach to determine if there is risk to human health or the environment, and implementation of interim corrective measures to accelerate cleanup of significant hazards. In addition, ERPO installations have successfully renegotiated regulatory agreements using the baseline to demonstrate the need for changes to regulatory deliverable deadlines.

The Pinellas ER Program Management System has helped to coordinate efforts between the assessment and remediation contractors and to assure that all regulatory deliverables are prepared and completed on time (in most cases, ahead of schedule). Schedules have been favorably received by the regulatory agencies. Additionally, an interim corrective measure is being implemented because of the positive regulatory interface and improved cooperation and coordination.

**Effective Program Management.** The ERPO System functions as a proactive project management system. Strong emphasis is placed on assuring that baselines are complete and realistic and that reporting and progress analysis is accomplished. Due to the magnitude of the program, "management by exception" has been selected for use in the reporting module of this system. The objective is to provide the appropriate level of management information and analysis to allow a proactive, anticipatory approach toward managing individual subprojects and resolving potential issues prior to their becoming a problem. Additionally, it provides integration of individual subproject management into total management of the overall project. At Pinellas, the quality of management information combined with subproject management integration has resulted in a track record of meeting 100% of regulatory requirements in the Hazardous and Solid Waste Amendment (HSWA) permit.

**Programmatic Credibility.** The ERPO System is built on the premise that the baseline must be defensible. This means it must include all work necessary to complete environmental restoration, provide adequate documentation of assumptions, and include reasonable cost and schedule estimates that are traceable to regulatory requirements. This provides a solid basis for budget requests, negotiating regulatory agreements and external audits.

The baseline provides a time-phased cost estimate of all tasks necessary to complete assessment and remediation of each subproject as required by the applicable regulatory drivers. The baseline is used as the basis for cost and schedule specifications in the Environmental Restoration/Waste Management Five-Year Plan. Thus, the baseline links the regulatory drivers and the Five-Year Plan. In Addition, this approach assures integration of realistic, defensible cost, schedule, and technical information into the primary document relied upon by DOE to present the overall ER strategy.

The Pinellas ER Program utilized the System as the basis for development of their FY93 Five-Year Plan Activity Data Sheets (ADS). Every ADS was supported by documentation of cost estimates relating directly to regulatory requirements. As a direct result, the Pinellas budget for FY93 was supported by OMB at the full Program Planning Level.

Within the last twelve months, the AL/ER Project has undergone a great deal of internal and external scrutiny. This includes reviews by the General Accounting Office (four separate reviews), House Appropriations Committee, Office

of Inspector General, Office of Management and Budget (OMB)/Corps of Engineers (COE), DOE/PR-20 Independent Cost Estimate (ICE) Team, DOE/EM-24 Cost Quality Management Assessment Team, EM-45 FY93 Five-Year Plan Validation Team, EM-43/PR-20 Baseline Validation Team, and the AL/ER Project Systems Review and Baseline Validation Team. Installation baselines with supporting documentation have served as the basis for successful closure of each review and/or audit performed to date.

The Pinellas ER Program participated in many of these reviews/audits. Here, the baseline documentation served to minimize the amount of time required to support scope, cost, schedules, and milestones. The System also provides the mechanism to cross-cut data and provide quick response to support requests for additional information from on-site audit teams. Pinellas ER audits to date have resulted in no significant adverse findings.

### LESSONS LEARNED

Application of "lessons learned" is critical to developing, implementing, and improving a successful cost/schedule control system. Below are several areas of consideration identified during development and/or implementation of the ERPO System which can be beneficial to other environmental projects developing similar systems:

**System vs. Software.** It is important to note that the ERPO Project Management System is based on a specific approach, not specific software. The AL complex consists of eight installations located across the United States. The management and operating (M&O) contractors at these installations face unique installation-specific technical ER Program issues and regulatory drivers. Restrictions on software, given this diversity, becomes a programmatic deterrent. ERPO guidance on software is that the installation select easy-to-use, menu driven, off-the-shelf software, compatible with the database programs which ERPO uses to generate the monthly report.

**Reporting.** Although the ERPO System is built around a common cost/schedule approach, each installation has a unique structure in place to meet specific management needs. Therefore, it is imperative that flexibility to manage programs remain in the field and that reporting of program progress be done based on those commonalities inherent in all cost/schedule control systems. DOE Order 1332.1A, Uniform Reporting System has identified standard reporting formats which utilize standard performance measurement elements for data analysis. Utilization of these formats provides for reporting and analysis of that information which is essential for effective program management.

**Accurate Cost Data.** Since the System is developed for multi-use purposes such as internal program planning and management, the Five-Year Plan, the Congressional Budget Call, and the Progress Tracking System, accurate and systematic collection of performance data is critical to assure DOE's credibility in effective management of the ER Program and to accurately reflect DOE's total cost liability. When merging cost data from DOE's integrated accounting systems with the cost/schedule control system, recognition must be given to the differences between the two systems. These differences must be reconciled to assure that cost data reported in both systems are reflective of the actual work performed and all costs

associated with that work, whether costs have been invoiced or not.

**System Development.** Application of C/SCSC was originally intended for facility construction projects. Environmental Restoration has unique characteristics that are not common to facility construction which must be taken into account. Parts of DOE Orders concerning project management and cost/schedule control systems cannot be applied directly to the Environmental Restoration Program effectively due to the following reasons: 1) significant up-front uncertainties that limit accurate design estimates prior to completion of assessment; 2) requirements driven by external sources; 3) issues inherent with the M&O procurement process; and 4) high public visibility.

Development and implementation of a successful project management system for ER requires an ongoing iterative process of assessment and enhancement. An annual self-assessment and/or system surveillance review assures that the System is developed and implemented to provide appropriate levels of information which will be utilized for proactive management of the project. Toward this goal, ERPO conducted an independent review and validation for each of the eight installation baselines to assure conformance, traceability, and acceptability. Additionally, an ER Project self-assessment review was performed to assure compliance with DOE orders and guidance for cost and schedule control. In the future,

self-assessments for compliance will become a routine function looking at both project management and technical areas.

**Training.** Optimum success in utilization of the System is dependent on adequate training of all program participants. Training should include formal cost/schedule training programs as well as internal system-specific training. Emphasis should be placed upon utilization of the system as a management tool as opposed to a reporting tool. Annual refresher courses should become a part of annual training programs.

#### SUMMARY

Development and implementation of the ERPO Project Management System is based on providing a mechanism that promotes credibility, accountability, and optimum cost and benefit for the Environmental Restoration Project. The ERPO System is based on a standard approach to cost/schedule control consistent with DOE Orders for project management of Major Systems Acquisitions.

The System provides many benefits such as: planning improvements, effective program management, and enhanced program credibility and traceability. Recognition of system vulnerabilities is a key step toward assuring success. Therefore, self-assessments, surveillance reviews, baseline validations, and general "lessons learned" are analyzed annually to identify areas for system improvements, thus, providing continual benefits to the Department of Energy.